1.0 SUMMARY AND CONCLUSIONS

1.1 Program Goals

Under the Comprehensive Environment Response, Conservation and Liability Act (CERCLA), Superfund Amendments and Reorganization Act and as part of the Defense Environmental Restoration Program, the Army Corps of Engineers (COE) has assumed the responsibility of remediating Formerly Used Defense Sites (FUDS) left as a legacy from World War I and World War II. These sites contain remnants of munitions used for training activity. Typically these sites involve impact areas for various types of explosives ranging from mortars to larger cannon and aircraft launched bombs and missiles. Not all the munitions detonated at the time they were initially launched, resulting in numerous unexploded ordinance (UXO) that have been left as "duds" at FUDS.

The COE is concerned with cleaning up these sites and needs to ensure that the FUDS are indeed safe prior to returning them to full public use. Local agencies want the FUDS and use of the lands for the public but are wary of UXO at these sites. They are concerned with the public being harmed by a UXO and the net effect of local ecosystems being contaminated by UXO residues from washout.

Some sites have already been returned to local agencies for public use. The COE is currently contracting with explosives capable firms to locate, remove and properly dispose of UXO at these sites. These firms "sweep" high use areas with metal detectors to locate and subsequently remove the UXO by digging them up. Disposal involves detonating the UXO where it is found (blow in place of BIP or removing the UXO to a disposal area and detonating it there (open burning / open detonation) with other UXO as they are found, usually on a daily or weekly basis. Local agencies are concerned with the environmental contamination that may be caused by detonating these items at disposal areas on site.

Of major concern to this study are the Time Critical Restoration Actions (TCRA) requiring immediate search and disposal actions because of potential hazard to persons with ready access to FUDS. This study addresses the issue of potential contamination due to explosive products in the immediate area of the explosions.

Initially this program was to obtain measurements of analytes in soil and water samples from TCRA activities at four FUDS where cumulative unexploded ordnance and initiator explosive yields were large (order of several hundred to near 1000 pounds of net explosive weight or NEW). Other constraints on selection of sites included (a) baseline samples in OB/OD area were required prior to remediation activities and (b) the collection area was selected as to yield meaningful results. The requirement to collect

virgin soil samples ruled out sites already in the remediation process. The sites available in the time frame of this study were Camp Claiborne in Louisiana and Camp Grant in Illinois. Therefore, measurements at four sites would not be accomplished in this study leaving resources which were applied to a more thorough test program at Camp Claiborne and at Camp Grant.

Test results were to be used to validate models predicting concentration of analytes in soil using detailed dispersion models. However, the levels obtained were all below detectable limits and key emission factors for initiator explosives were not available so that approximate models were justified. Modeling efforts which were conducted are reported herein as are the results of laboratory assay of soil and water samples.

1.2 Soil Sampling

The availability of sites from which samples could be collected for analysis was restricted due to the requirement that all sampling had to occur during the period of performance of this contract task. Some potential sites could not be selected because operations had already begun at the site and therefore no clean background samples could be collected to establish site specific analyte reference levels. Camp Croft in South Carolina was one of these. Others would not have operations completed prior to the end date of the task. The former southwest proving Ground at Hope Arkansas ultimately fell into this category due to a contract delay. In addition, sites that were recently active would possibly have too much munitions and explosives residues to allow clean background samples to be taken to establish baseline conditions for the site. Fort Ord in California was one of these.

The two sites selected for sample collection, Camp Claiborne, near Alexandria LA, and Camp Grant, near Rockford IL were the best choices based on the time frames for cleanup, potential for ordnance to be located and destroyed and the fact that no hazardous material appears to have been introduced since the end of WW II.

The sampling plan developed for open detonation of UXO at TCRA sites was developed to be flexible and allow variations dictated by each site. In fact modifications were made for both sites because of site peculiar circumstances. Three sampling events occurred at both sites: (a) Initial sampling used to establish background conditions; (b) Immediate post detonation sampling; to monitor for disposal activity influences, and (c) Post detonation sampling at project close out to monitor accumulated effects of multiple disposal activity (referred to in this report as Post Disposal).

The initial sampling was used to establish existing background conditions before open detonation /disposal activity had occurred. This involved sampling of soils and, if

available, any surface water existing at the site. Samples were collected in accordance with the sampling plan contained in Volumes II, III, and Section 6.0. This involved sampling of the disposal area, or anticipated ground zero location, and two samples or more in each of the cardinal compass directions at set radial distances from the disposal site. Samples collected consisted of natural occurring soils at each site. An occasional water sample was taken if surface water was available.

Immediate post detonation sampling was done using two pans for each compass direction (N, E, S, and W) at set distances according to the anticipated net explosive weight (NEW) of each detonation. These pans collected dust and fallout from the detonation cloud, and in some cases were hit by and collected ejecta that originated from ground zero.

Post disposal samples collected at project close out were obtained from ground zero and at the same direction and distances along the four compass axes. These samples were taken from soil in the top 1/8" of ground surface. If available, water was also collected from both sites near ground zero. Figures 1.1 and 1.2 show the sampling locations at Camp Claiborne and Camp Grant for pre, post first detonation, and post disposal activities.

Laboratory analysis of each sample submitted for testing involved both metals and organic analysis. Specific Tests run were made for (a) Metals analysis using EPA Method SW-846-6010, (b) Nitrates using Method SW-846-4110B, (c) Base Neutral Acid compounds using Method SW-846-8270/625, and (d) Nitroaromatics and Nitramines using Method SW-846-8330.

An initial list of target analytes was developed based on anticipated UXO and initiator explosives and igniters. This list was expanded to include other compounds which experience suggested might be present and some which are provided as part of laboratory assays by the analysis laboratory. Target analytes are provided in Table 2.4 and in Volumes II and III for Camp Claiborne and Camp Grant respectively. Method detection limits are provided in the appendices of these volumes.

Results of analysis indicated that there was limited contamination existing in background samples and none from immediate post detonation fallout or post disposed ground samples.

There was detection of some contaminants which we believe do not result from the explosion. An occasional sample resulted in very low detection of dibutyl phthalate and/or bis (2-ethylhexyl)phthalate. These are common laboratory contaminants and sporadic detection of this chemical at very low levels occurs routinely since it is used as a plasticizer in gloves used both in sample collection and laboratory handling and in plastics used as containers for initiator explosives. Since it appeared in only a few

occasions and not on a regular basis, this chemical should be considered a “laboratory” induced contaminant and not a site contaminant.

1.3 Conclusions and Recommendations

For the size of detonation activity used for disposal of UXO encountered on site, neither large or small explosions resulted in measurable semivolatile residues in soil or water sampled on site. This condition held for monitoring done immediately after initial detonations and post disposal activity following close-out of TCRA operations. The levels of metals present in the assay are not considered hazardous.

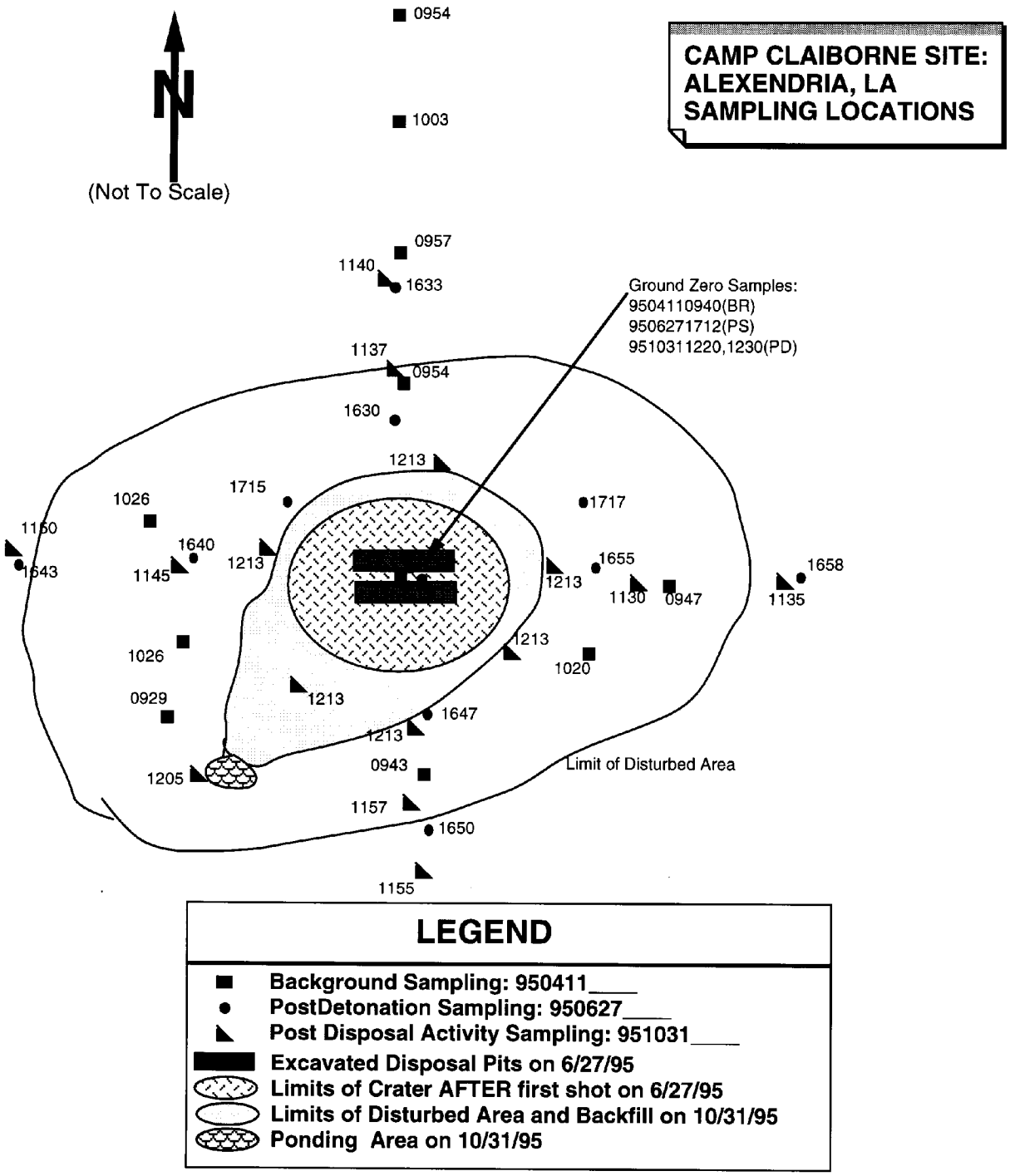

Figure 1.1 Sampling Locations at Camp Claiborne, Louisiana Site

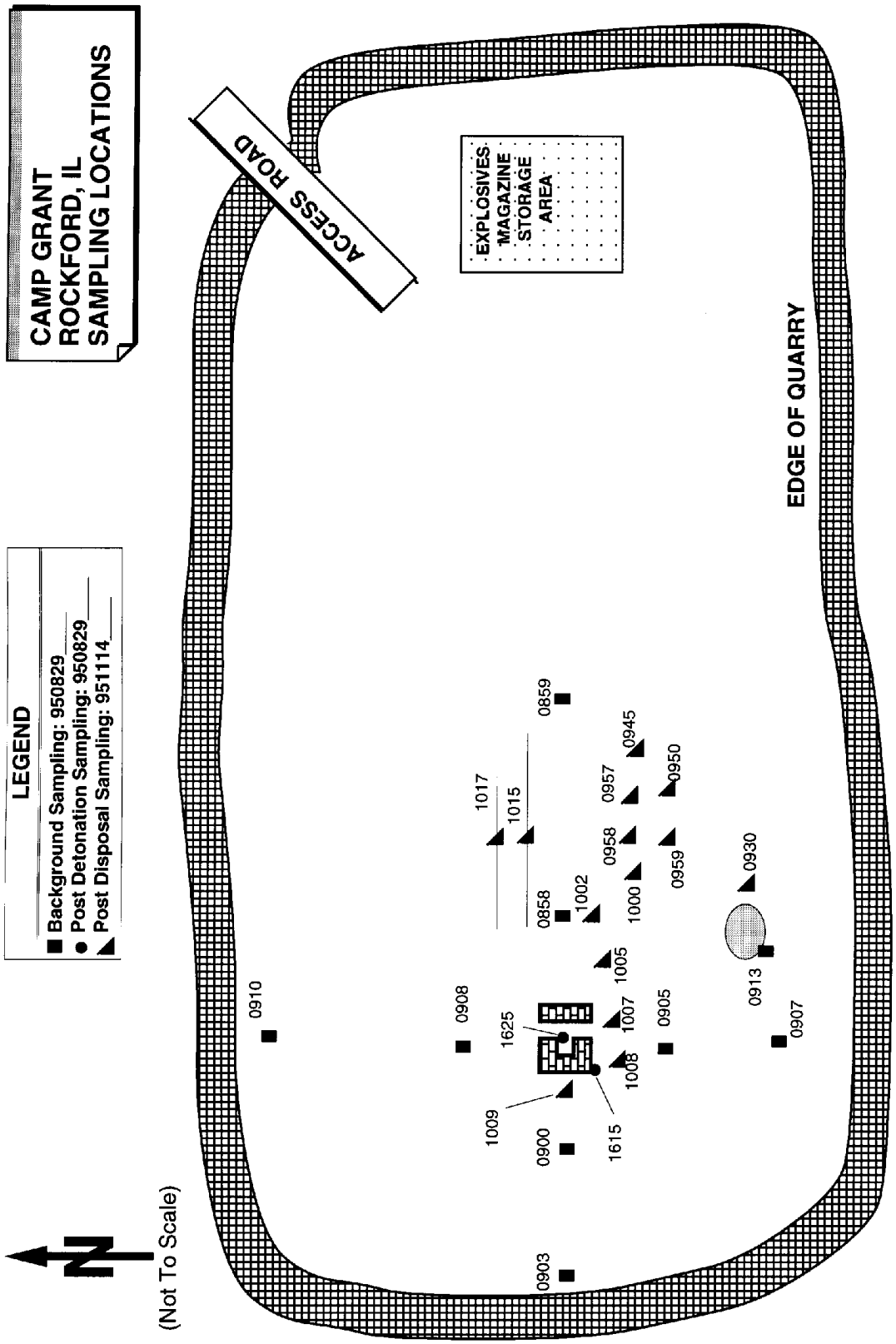

Figure 1.2 Sampling Locations at Camp Grant, Illinois Site

From these results it is concluded that the current open detonation (OD) practices for disposal of unexploded ordnance at FUDS will not lead to ground or water contamination levels of concern to EPA or local state agencies. Since detectable levels of explosive related contaminants were not observed, nor were emission factors available for the initiator explosives, correlation with dust and fallout models could not be made, therefore, approximate relations were used as required.

Conditions observed at the two sites in this study involved FUD sites that were expected to have minimal to no observable background contamination. This is due to the fact that most of the contaminating activity occurred at least 50 years ago. This would allow sufficient time for any released contaminants to naturally attenuate or degrade to a point of not being detectable as background contamination in the environment. These same conditions may not be applicable to sites that are more heavily contaminated as the case with recently used active and high use impact areas and bombing ranges.

The main contaminants of concern involved are, Metals, TNT, Nitromethane and Ammonium Nitrates. No notable contamination involving these explosives or their by-products was found in any samples. These same results would be expected using more exotic explosives(such as PBX, RDX and others), however, an opportunity to measure these compounds at the sites under study was not available. Pyrotechnics, were similarly not measured, however due to the high metals content found in flares and rockets one would expect more contamination involving metals.

Based on the work performed in this study, The following baseline for open detonation of UXO is provided.

a. An open pit or trench should be dug to a depth of 3 to 4 feet (depending on explosive charges involved). Multiple trenches or pits close together (<2 feet apart) can be used.

b. Initiator charge and explosive yield of UXO buried in these pits should be less than 150kg total for each detonation. (The data from which these conclusions are drawn are based on a total of all detonations less than 500 kg NEW at Claiborne.) Where the total NEW is expected to exceed the sum of 500kg (1100 lb), a separate site or detonation operations is recommended. If this cannot be accomplished, measurements of soil (parameters) before, and contamination after the TCRA should be obtained. This can determine if the resulting contamination levels are significantly above background measurements (if they exceed an order of magnitude difference over background conditions) or exceed local EPA of guidelines, if they exist. The analyte list in Table 2.4 is recommended. This list could be made smaller, but

would not materially change the laboratory costs. If NEW is larger than 2000kg, collection of airborne samples and down range fallout should be considered. For NEW over 10,000 kg we consider airborne and down range fallout monitoring a requirement.

c. All procedures as recommended by the TCRA contractor regarding UXO, initiator explosives, fuzing, safety, etc. must be followed.

d. The pit with explosives and UXO's should be filled with clean sand so that explosives are at least 4 to 5 feet below the surface of the tamping material. After each shot the same crater can receive additional UXO and initiator explosives and should be filled with clean sand as above for sequential operations.

e. Selected demo sites should be as far as possible from running water or ponds/lakes. If this is not possible, surface water samples should be taken immediately after each shot and analyzed (downstream if running water, timed to sample when fallout is estimated to have reached sampling point).

f. After completion of operations, the crater(s) should be backfilled with soil from the general area, mounded slightly so that settling will return the surface to the original contour, and left in a smooth condition. Any sand remaining can be spread over the general area or introduced into the crater(s) before backfilling. If aesthetics is a factor, scarification and grass seed should be spread over the disturbed area.

Additional recommendations include:

a. Emissions and emission fractions should be determined for KINEPAC and other Nitromethane and Ammonium Nitrate based explosives. This will provide data for subsequent dispersion and fallout simulations. The BangBox (BB) facility should be utilized.

b. Update and develop appropriate distribution of semivolatile attachment to particulates lofted into the air for subsequent fallout analyses using dispersion codes which model puff (explosive) inputs.

c. Determine the scaling with NEW and the effect of depth of burial particularly in disturbed, highly non-homogeneous media such as exists in backfilled pits and craters.